face absorption of the wave makes it almost impossible to check the mathematical theory which has been given.

(2) The second book before us for review is a third edition of Dr. Erskine-Murray's well-known "Handbook of Wireless Telegraphy." The present edition contains a considerable amount of new matter, but the explanations given of fundamental effects, such as the creation of Hertzian waves, are somewhat too brief to be very useful. The student is not much assisted merely by reproducing on a double page Hertz's well-known diagrams of the electric radiation of a dumbbell oscillator accompanied only by an extract from Hertz's own book, and without further elucidation of the difficulties involved. Rather too much space is occupied in some parts by extracts from original papers, whereas the essentially new information could be concentrated and difficulties removed by a more independent authorship.

After the usual introductory chapters dealing with early history, three chapters follow on detectors for electric waves, considerable space being given to the theory of magnetic detectors and descriptions of forms which have not been much used for radiotelegraphy, whilst the contact or rectifying detectors are very briefly treated. With regard to Fleming's glow-lamp detector, the erroneous remark is made that Dr. de Forest "improved this detector." As a matter of fact, his improvements did not enable it to operate better than in its original form. Chapters viii., ix., x., xi., and xiii. are devoted to descriptions of the Marconi, Lodge-Muirhead, Fessenden, Hozier-Brown, de Forest, and Telefunken "systems" of wireless telegraphy. All of them, however, involve essentially the same system, viz. the spark method, and differ only in the details of the apparatus used. A chapter, which is, however, interesting, is given to methods and apparatus which have never reached the practically efficient stage, such as the "world wave telegraphy" described in chapter xviii., in which Tesla's somewhat tentative experiments are discussed. There is no evidence that any useful telegraphic work has been carried out by these methods.

In the chapter on theories of transmission, a large amount of information is collected on the influence of atmospheric states on radiotelegraphic transmission. Facts are being accumulated which seem to connect variations in received signals over long distances with changes in atmospheric electricity. Much work has yet to be done before a satisfactory theory can be evolved, and it is therefore perhaps premature to attempt to construct such theories in text-books issued now. For one thing, we need much more information than we now possess as to the variation in atmospheric conductivity at high elevations, which may some day perhaps be provided by the use of dirigibles or aëroplanes.

Dr. Murray's book concludes with a useful chapter on high-frequency electric measurements and appendices containing many valuable practical tables, curves, and memoranda. The book is well printed and fully illustrated, and certainly one to be included in any radiotelegraphic library. J. A. F.

THE SCIENCE OF SHIPBUILDING.

The Design and Construction of Ships. By Prof. J. H. Biles. Vol. ii., Stability, Resistance, Propulsion, and Oscillations of Ships. Pp. x+428. (London: C. Griffin and Co., Ltd., 1911.) Price 25*s.* net.

THIS second volume was originally intended to complete the work, but the author found his materials growing rapidly and wisely decided to develop more fully in a third volume his treatment of ship-designing. Like the first volume—reviewed in NATURE, February 18, 1909—the second is complete in itself. It will be of much value as a text-book for advanced students of naval architecture, and as a book of reference for men engaged on the practical details of ship-design. The contents are arranged in four sections; in which the stability, resistance, propulsion, and oscillations of ships are discussed. Under each head is presented an excellent *résumé* of the accepted theory of the subjects treated; in association with valuable data, drawn from recent practice, illustrating the characteristics of various types of ships. A mass of information which was previously widely scattered in various publications has thus been concentrated, including published results of the latest experimental research work.

In dealing with the geometric theory of stability the author has naturally followed the lines laid down by M. Charles Dupin in his memoir entitled "Stabilité des Corps Flottants" (published in 1814), one of the series of "Applications de Géometrie" presented to the Institute of France. Dupin for all practical purposes exhausted the subject, although certain corrections and extensions of his generalisations have since been made by other investigators, more especially as the result of determinations by calculation and experiment of the stability of actual ships made during the last forty years. Prof. Biles describes the methods of calculation, as well as the ingenious integrating instruments (devised by Amsler and others) by means of which arithmetic labour has been greatly reduced. Typical examples are given of curves of stability constructed for many classes of ships, and for different conditions of lading; and the whole section has been arranged in a manner which will enable advanced students to master present knowledge of the subject, while draughtsmen and others who are engaged in the work of calculations of stability will find help and guidance.

From the middle of the eighteenth century mathematicians and experimentalists have been attempting general solutions of the problems of water-resistance to the motion of ships, but with moderate success, and with small practical influence on ship-design, until the late William Froude, little more than forty years ago, introduced the system of experiments on models. Froude demonstrated the law of comparison between ships and models moving at "corresponding speeds," and showed how to make the necessary correction for frictional resistance when passing from models to ships. Model experiments are now universally regarded as necessary to successful steamship design,

when precedents have to be surpassed or greater speeds obtained. They can be applied both to the determination of the ship-forms most suitable under the conditions of a given problem, and to the selection of the most efficient propellers.

The first experimental tank, designed and built by Froude, was placed at Torquay, near his residence. It was comparatively modest in size and equipment, and was not intended to be permanent; but it continued at work for many years, first under the direction of the founder, and then under that of his son (Mr. R. E. Froude, F.R.S.), and yielded remarkable results, greatly to the benefit of the designs of ships of the Royal Navy. About twenty-seven years ago the Admiralty decided to construct at Haslar (near Portsmouth) a larger and better equipped experimental tank, to the designs of Mr. R. E. Froude, who has happily continued ever since in charge of its operations, and has greatly developed the system. This Admiralty tank has been the pattern adopted for tanks subsequently established in this country by a few leading firms of shipbuilders, and for many tanks established abroad. France, Germany, Russia, Italy, the United States, and Japan have followed the lead; and the latest, largest, and best equipped of the series is that which has been added to the National Physical Laboratory by the generosity of Mr. Yarrow. The primary purpose of that tank is the conduct of systematic experimental research, and great results may confidently be anticipated from its operations. Previous tanks have necessarily been chiefly devoted to experiments on models representing ships which are to be built, and pure research work has had to yield to more pressing requirements. At the same time, it is but fair to recognise the fact that many very valuable results of a general character, influencing the selection of the most suitable ship forms and propellers, have been published already. Mr. R. E. Froude (with the sanction of the Admiralty) has been the principal contributor; but Mr. Taylor, the superintendent of the United States tank, Colonel Rota of the Italian Navy, Prof. Sadler of Michigan University, and others have added to available information. Prof. Biles has summarised and analysed the results of tank experiments in the present volume, and has undertaken the labour of presenting the facts in a condensed and practical form; he has thus rendered a service to all who are interested in the subject.

Closely connected with the resistance experienced by ships in motion is the subject of propulsion, which is treated in the third section of this book in an adequate and practical fashion. Model experiments on propellers have been, and are of great value, but they require to be supplemented by trials on full scale. The author has brought together available data and indicated the need for further information. He states the conditions which chiefly govern the efficiency of screw propellers, and gives details of the methods of designing them. Progressive speed trials of actual ships are described and recommended, and there is universal agreement that such trials are essential to success in the practical application of model experiments. Numerous examples are given of the results obtained from experiments both on ships and models.

The subject of the oscillations of ships in still water and among waves furnished the opportunity for a second great contribution by the elder Froude to the science of naval architecture. His work in this direction really constituted a new departure in ship-design. Much has been learned from experiments both with ships and models since Froude indicated the way, and a great deal has been done towards endowing ships with greater steadiness and limiting their oscillations. This result has been due in part to a better understanding of the problem and partly to the use of bilge keels, moving weights, internal water tanks, and other special arrangements the action of which tends to limit the range of oscillation of ships in a sea way. These arrangements are discussed by Prof. Biles, and the effects produced by their use are illustrated by results observed on board ships when in actual service at sea.

Although this book is primarily intended for the use of students of naval architecture, it will be seen from the foregoing summary of its contents that it deserves a wider circulation. It should, in fact, have an interest not merely for students and naval architects, but be welcomed by mathematicians and others, to whom the subjects treated and the experimental results recorded should offer many attractions. W. H. W.

JURASSIC AND CRETACEOUS STRATIGRAPHY.

Traité de Géologie. By Prof. Emile Haug. Vol. ii., Les Périodes géologiques, fasc. 2. Pp. 929–1396. (Paris: A. Colin, n.d.) Price 10 francs.

THE Jurassic and Cretaceous systems were for long the most popular among British geologists, and the former will always be of special interest as the principles of historical geology were established by William Smith from work on the Jurassic rocks of the south-west of England. The second part of the second volume of Prof. Haug's "Traité de Géologie" is devoted to these two systems, and we are glad to note that he retains the Rhætic in the Jurassic. The work is of great value as a summary of a wide range of recent research, and its excellent photographs illustrating many well-known Continental localities are of unusual artistic merit. The book is a useful complement to the great treatise of de Lapparent, with its invaluable tabular correlations. Prof. Haug gives short, readable summaries of the stratigraphical classification and geographical distribution of the formations, and deals especially fully with the bathymetric conditions of their disposition. Lists of characteristic fossils are given, and he wisely gives only generic names. Exception may be taken to some of his palæontological conclusions, such as the affinity of Tetracidaris to Archæocidaris.

The amount of space devoted to different areas is very uneven. In spite of the historic importance of the English Mesozoic rocks, they receive very scant attention. Thus the list of literature on the Jurassic contains 361 titles, of which only eighteen, including eight by Mr. Buckman and two by Prof. Pavlov, deal with the British Jurassic. He apparently considers that British Jurassic geology has not been kept up to date, and remarks that it is difficult to determine